Powering positive change

The Hatch H.G. Acres symposium

April 15-16, 2025 | Hotel X, Toronto, Canada

Your guide to the event:
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Data science and probabilistic risk analysis for large transmission & distribution projects

Jakub Gara
Asset Management Lead, North America, Hatch

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Agenda

1. Introduction to asset management applications
2. Failure prediction
3. Value-based asset planning
4. Climate risk assessment
5. Data analytics road mapping
6. Discussion

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Breadth of Asset Management domain within T&D

Distribution & Smart Grid

Hydropower and dams

Power Transmission & Integration

Nuclear power

Renewable power

Hatch's key utility asset management offerings

Strategic Asset Management

- AM Frameworks & Mechanisms
- New Technology AMPs
- ISO 55000 Maturity Assessments
- Data Roadmaps (ISO 55000 aligned)

Asset Performance & Lifecycle Management

- Asset Reliability Forecast
- Performance Modelling (Failure Curves)
- Asset End of Life Interventions & Extensions
- Health Indexing & Predictive Analytics

Asset Investment Planning

- Demand Analysis & Value Framework Development
- Capital Program Support & Investment Scheduling
- Risk and Value Based CAPEX & OPEX Planning
- Grid Modernization Capital Investment Support

Digital Asset Management Solutions

- EAM & ERP Platform Support
- AIP & APM Software Integration
- Data Governance (ISO 14650)
- Gap Assessment

Advisory

Climate change

Digital

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Four AI Use Cases

1. Asset Failure Curves

Develop failure curves for selected transmission and distribution assets; test results in existing asset planning framework and Typical Useful Life (TUL) estimate.

2. T&D System Risk

Develop and/or review risk assessment used for HVDC transmission system, proposing a comprehensive, tailored approach.

3. Climate Risk & Vulnerability

Assess the risk of changing climate patterns on the T&D system, due to increased asset degradation and catastrophic events.

4. Data Analytics Roadmap

Assess current state of data/analytics capabilities and develop an actionable roadmap to enhance systems/processes.

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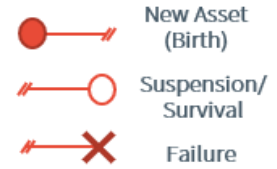
Probabilistic Asset Management

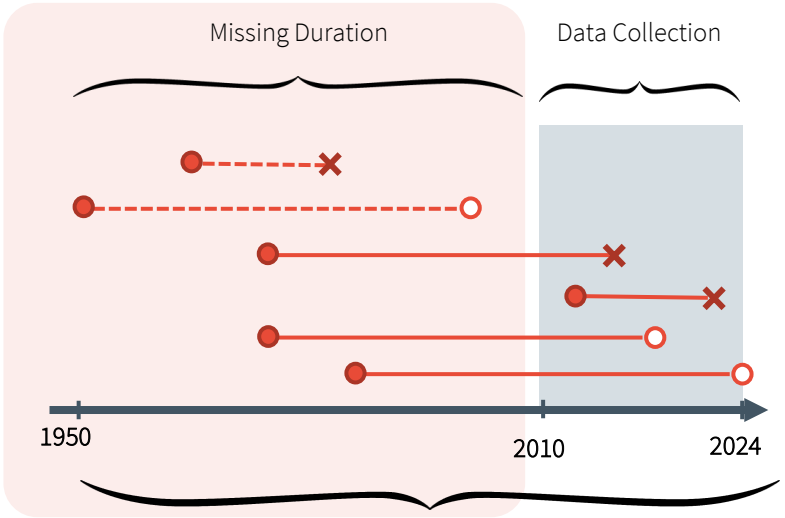


Systematic data challenges in Asset Management

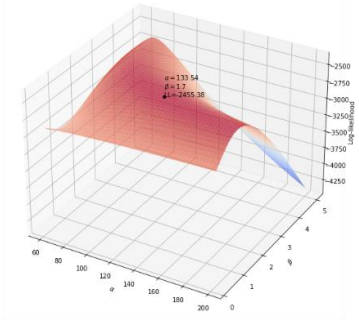
- ✓ General lack of data.
- ✓ **Right censoring effect:** failure data vs in-service data
- ✓ **Left truncation effect:** data collection duration vs early install year

Toolset and methodologies to address data challenges

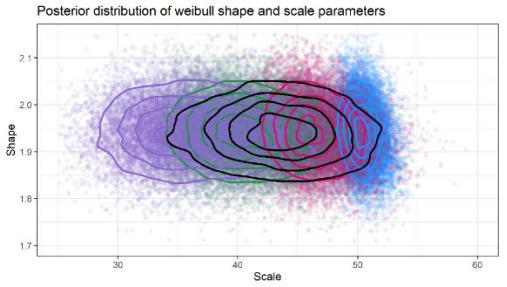
- M0: Just failures
- M1: Right censored
- M2: Maximum life limit
- M3: Left truncation
- M4: Poisson bootstrapping and synthetic simulations
- M5: Bayesian parameter updating



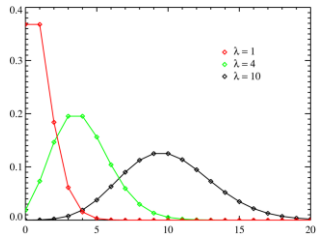
Overall Duration
(Early assets life)



Maximized
Likelihood Surface



Bayesian Probabilistic Estimate of
Failure Curves



Simulating asset population
growth

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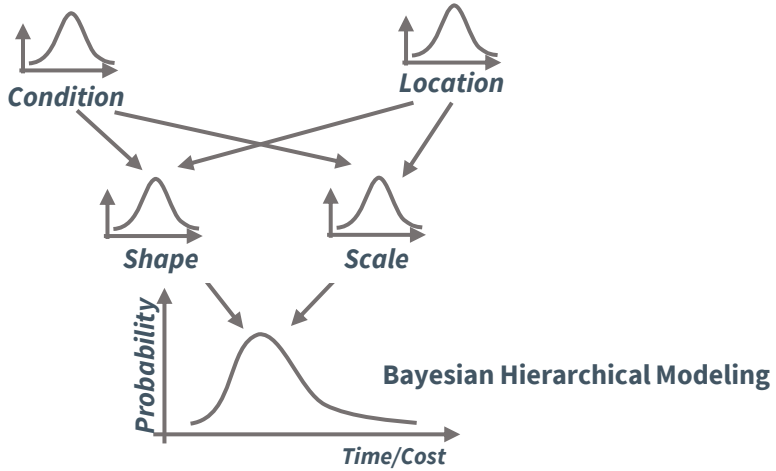
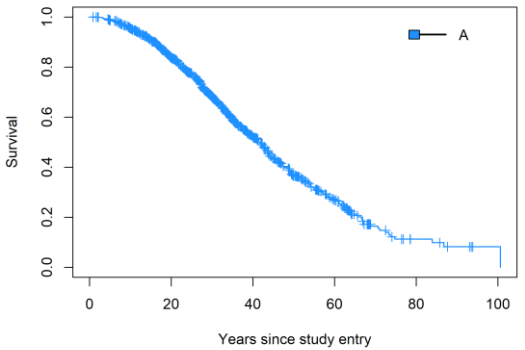
Bayesian Parameter Updating

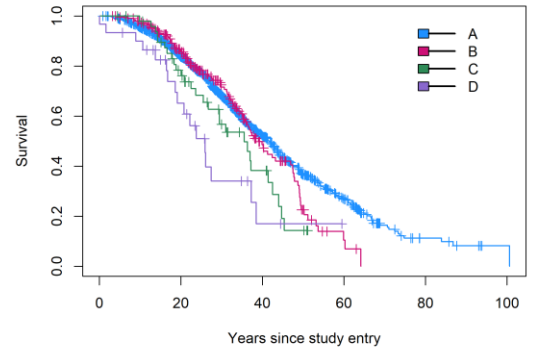
Condition Based Failures Curves

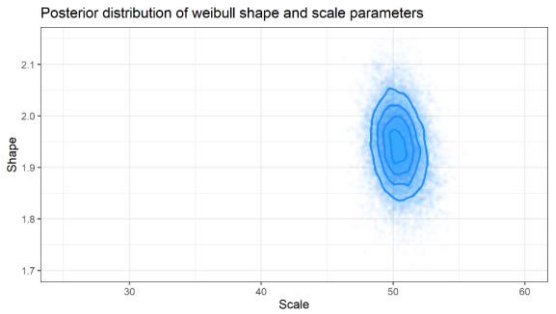
Asset failures and suspensions (hypothetical):

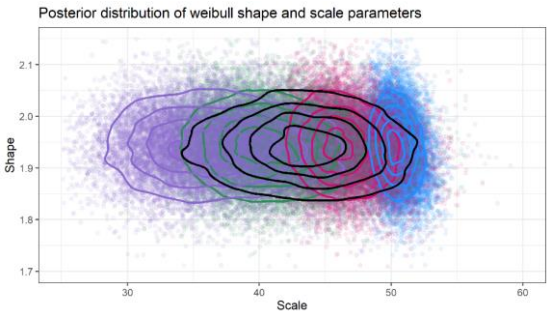
- ✓500 failures, 500 suspensions for A
- ✓100 failures, 100 suspensions for B
- ✓25 failures, 25 suspensions for C
- ✓15 failures, 15 suspensions for D

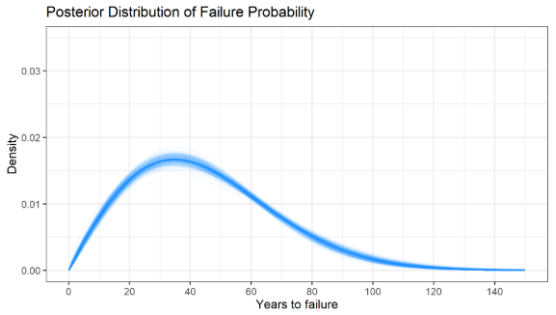


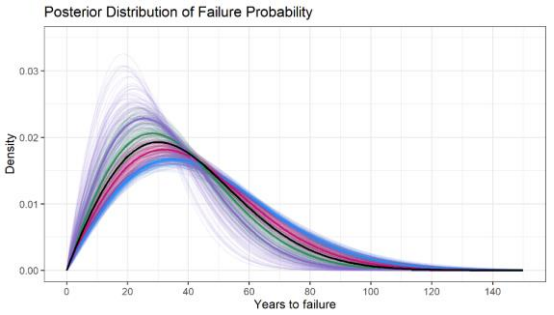












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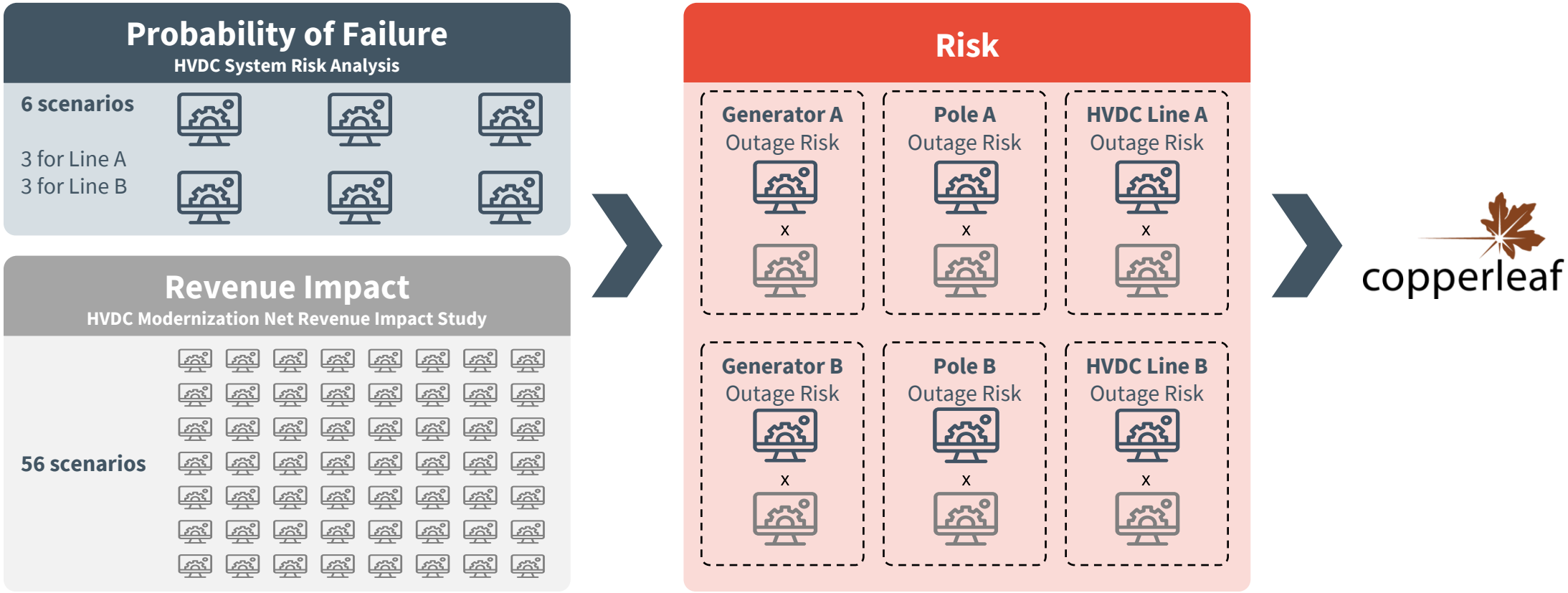
Reliability Study – Large Transmission Utility



The Risk calculation occurs in Copperleaf, which accepts input from the POF and revenue impact analysis, and assigns them into the appropriate POF and COF "bucket" as per Utility's Value Framework

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Heat Map assessing Climate Risk Assessment

Likelihood Table

Wind Gust Between 81 and 100 km/h	Baseline (1950-2020)	Study Period (2021-2075)
Service Territory 01	[1, 1, 1]	[1, 1, 1]
Service Territory 02	[1, 1, 1]	[1, 1, 1]
Service Territory 03	[4, 4, 4]	[4, 4, 4]
Service Territory 04	[4, 4, 4]	[4, 4, 4]
Service Territory 05	[4, 4, 4]	[4, 4, 4]
Service Territory 06	[5, 5, 5]	[5, 5, 5]
Service Territory 07	[5, 5, 5]	[5, 5, 5]
Service Territory 08	[5, 5, 5]	[5, 5, 5]
Service Territory 09	[5, 5, 5]	[5, 5, 5]
Service Territory 10	[5, 5, 5]	[5, 5, 5]
Service Territory 11	[5, 5, 5]	[5, 5, 5]
Service Territory 12	[4, 4, 4]	[4, 4, 4]
Service Territory 13	[1, 1, 1]	[1, 1, 1]
Service Territory 14	[5, 5, 5]	[5, 5, 5]

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Consequence Table

Wind Gust Between 81 and 100 km/h	Study Period (2021-2075)
Service Territory 01	1
Service Territory 02	3
Service Territory 03	2
Service Territory 04	1
Service Territory 05	2
Service Territory 06	2
Service Territory 07	3
Service Territory 08	3
Service Territory 09	3
Service Territory 10	2
Service Territory 11	4
Service Territory 12	3
Service Territory 13	3
Service Territory 14	3

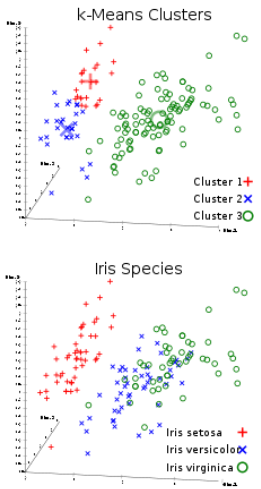
»

Risk Profile

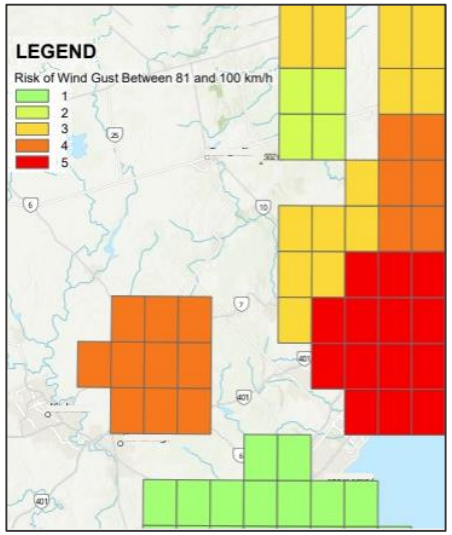
Wind Gust Between 81 and 100 km/h	Baseline (1950-2020)	Study Period (2021-2075)
Service Territory 01	[1, 1, 1]	[1, 1, 1]
Service Territory 02	[3, 3, 3]	[3, 3, 3]
Service Territory 03	[8, 8, 8]	[8, 8, 8]
Service Territory 04	[4, 4, 4]	[4, 4, 4]
Service Territory 05	[8, 8, 8]	[8, 8, 8]
Service Territory 06	[10, 10, 10]	[10, 10, 10]
Service Territory 07	[15, 15, 15]	[15, 15, 15]
Service Territory 08	[15, 15, 15]	[15, 15, 15]
Service Territory 09	[15, 15, 15]	[15, 15, 15]
Service Territory 10	[10, 10, 10]	[10, 10, 10]
Service Territory 11	[20, 20, 20]	[20, 20, 20]
Service Territory 12	[12, 12, 12]	[12, 12, 12]
Service Territory 13	[3, 3, 3]	[3, 3, 3]
Service Territory 14	[15, 15, 15]	[15, 15, 15]

Historical data simulates future grid impacts through:

- Single/multi-variable historical outage-weather Customer Interruption (CI)
- Weather predictors: wind, temperature, precipitation, extreme events
- Unsupervised machine learning algorithms:
  - K-Means, EM, Canopy clustering



Risk Map (Study Period)



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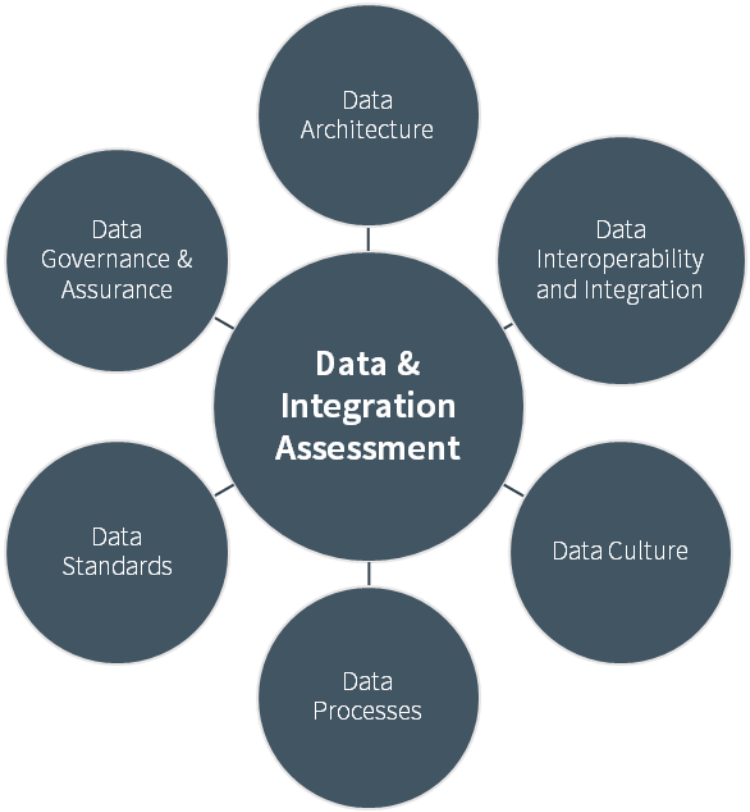
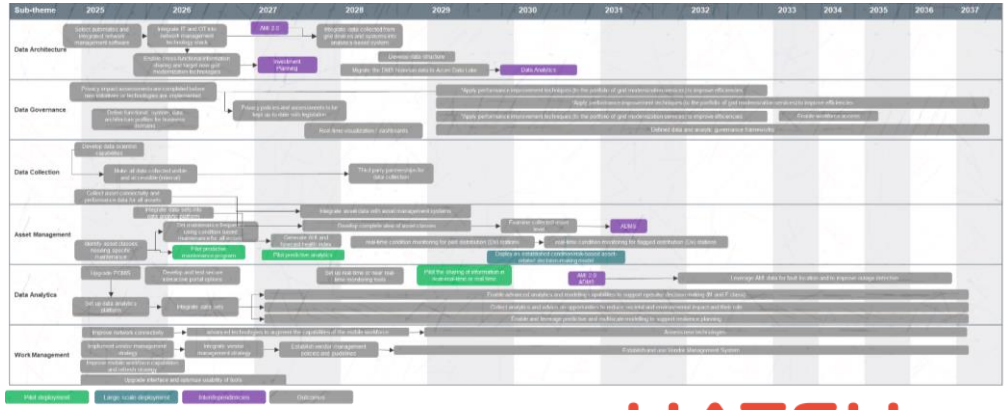
Data Analytics Roadmap

- Current State Assessment
  - ✓ Data sources, systems, platforms, data governance, and data management processes
- Gap Identification and Use Case Development
  - ✓ Key systems and processes across key functional areas
  - ✓ Define and prioritize use cases.
- Roadmap Development
  - ✓ Set of recommendations to advance from the current state to the future state.
  - ✓ Set of focused key performance indicators KPIs





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Innovation in Asset Management across Power

Key Takeaways

Risks

Risks awareness and mitigation planning

Technology

Fit-for-purpose technology stack

Data

Utilizing existing data

People

Asset Management of your KEY ASSETS

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Questions

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Thank you.

For more information,
please visit www.hatch.com

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